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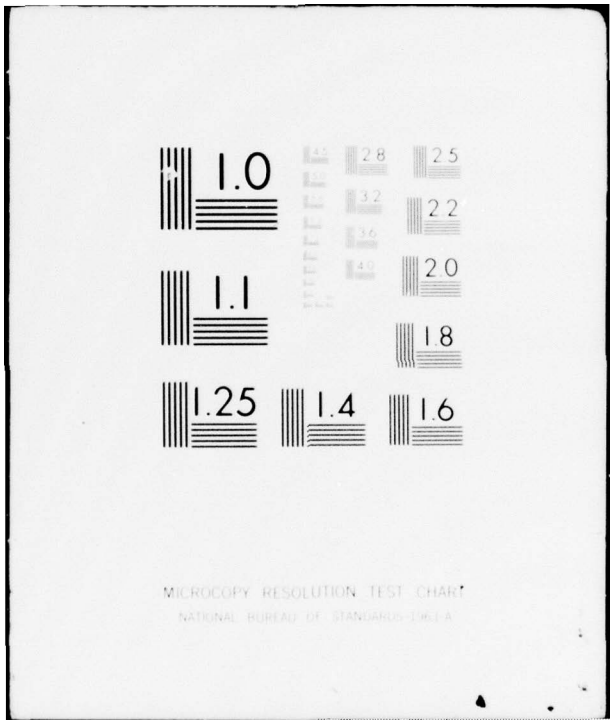
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END USE SPACE CONDITIONING EQUIPMENT COST DATA FOR USE IN TOTAL ENERGY SYSTEM ANALYSIS

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ABSTRACT

This report summarizes the capital cost data for end-use space conditioning equipment used in possible Total Energy Systems. The capital costs are extracted from literature and vendor surveys, and an average 'cost per unit of capacity' is derived. The end use equipment under study includes compressive air conditioners, electric base-board resistance heaters, heat pumps, and electric hot water heaters. The unit costs derived herein are applied to the economic model of Total Energy System studies.

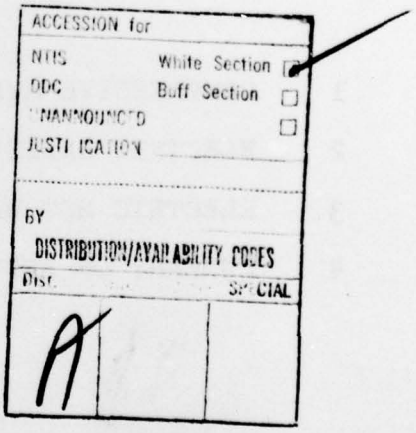

TABLE OF CONTENTS

LIST OF TABLES

1. INTRODUCTION

The purpose of this report is to derive the capital costs of the end-use equipment which would be used in possible future Total Energy Systems [1]. End-use equipment is defined herein to be electrically operated space-conditioning or water heating components generally found in household use. Included in this study are compressive air conditioners, heat pumps, electric resistance baseboard heaters, and electric hot water heaters.

The method of determining the costs of end-use equipment is based upon a literature and vendor survey. Data is compiled for various models of equipment, where feasible, and an average capacity and associated price are determined. Thus the cost model used is a "typical" value based on equipment that is currently available commercially. The cost is then divided by the capacity to obtain a cost-per-unit-capacity ratio. This value, when multiplied by the appropriate energy requirement of a building, yields the effective cost of equipment needed to satisfy that building's energy demand. Although monetary savings in equipment cost can be realized by economies of scale for large energy users, this effect is not considered to be significant for the purpose of this study since approximately 90% of the buildings which would be served by a community Total Energy System are small residential units.

A discussion of the derivation of the costs of the end-

use equipment components is presented. All prices quoted are in 1977 dollars.

2. COMPRESSIVE AIR CONDITIONERS

The compressive air conditioners analyzed are window-mounted units with rated cooling capacities between 7500 and 8500 Btu per hour. Table 1 lists the data accumulated. Installation costs are considered to be negligible. It is seen that the unit energy costs vary among retailers; this is due to effects of a combination of manufacturer's list price and dealer markup. The average cost per thousand Btu per hour of cooling capacity is $37.25.

A nominal 8000 Btu per hour unit would then cost approximately $300. However, local (Boston area) dealer spot checks show that 8000 Btu units can be obtained for $270. As such, a cost of $250 for an 8000 Btu unit is not unreasonable when discounts for bulk buying are considered. Therefore a unit cost of $31.25 per 1000 Btu capacity is recommended for Total Energy System analysis purposes.

3. ELECTRIC RESISTANCE HEATERS

Electric baseboard resistance heaters offer low capital costs and high operating expenses for a heating system since the Coefficient of Performance (COP) of such devices is unity. Table 2 shows costs for units of various

capacities (note that these costs are dealer's costs). The unit price recommended for purposes of analysis is $25.00 per Kilowatt of heating capacity. In addition, a thermostat ($20.00) and additional wiring and parts ($20.00) are required for each building. Furthermore, a Boston Edison Company representative said that an additional $300.00 per house would be required for installation labor. He noted that each building varies in labor requirements, depending on its condition, but $300.00 is thought to be a good estimate. Therefore the unit cost of electrical resistance heating is recommended as

Cost-Resistance = $340 + $25/KW Heating Required.

4. HEAT PUMPS

Heat pumps offer a more efficient method of space conditioning because of their relatively high coefficients of performance (COP) and their dual nature. A heat pump unit can be used for both heating and cooling, thus eliminating the need for an air conditioner. A product analysis similar to the preceeding was undertaken, but using two different sources of information (the Boston Edison Company and the Trane Company). Both indicated that a basic rule of thumb for estimating smaller heat pump costs is a value of $1000 per ton of cooling capacity* installed (one ton

*The maximum capacity of heating or cooling

of cooling capacity is equal to 12,000 Btu per hour). This correlates with literature values. Therefore, for Total Energy System study purposes, the unit capacity cost for heat pumps is recommended as \$84.00 per 10^3 Btu per hour.

5. ELECTRIC HOT WATER HEATERS

Table 3 shows the cost data for electric hot water heaters. If the three highest unit price models are not included, the average resulting unit cost is \$3.22 per 10^3 Btu per hour, based on a hot water set temperature of 140°F. This cost would correspond to \$120 for a standard 52 gallon model. In order to discount dealer markup and bulk quantity benefits, a value of \$100 for a 52 gallon heater is recommended, with a unit cost of \$2.60 per 10^3 Btu per hour. Installation and wiring costs are approximately \$65.00 based on interviews with local contractors. This does not include new plumbing, however; the price is based upon installing a water heater into an existing home system. The unit cost for electric hot water heaters then is

$$\$65 + \$2.60/10^3 \text{ Btu}$$

6. SUMMARY

Table 4 summarizes the recommended cost data of this report. All prices are in 1977 dollars, and reflect wholesale costs.

TABLE 1

COMPRESSIVE AIR CONDITIONER COSTS

Vendor	Rated Capacity (Btu/hr)	EER*	COP**	Average Retail Cost(2)	Unit Cost ($/10^{3}Btu /hr, 1977)
General Electric	8500	9.9	2.9	$324	$38.12
Admiral	7700	9.1	2.7	$284	$36.88
Friedrich	8000	9.3	2.7	$350	$43.75
Amana	8500	9.9	2.9	$336	$39.53
Frigidaire	7500	8.7	2.5	$294	$39.20
Hotpoint	7500	8.7	2.5	$244	$32.53
Edison	8200	9.0	2.6	$251	$30.61
Airtemp	7500	9.1	2.7	$309	$41.20
Fedders	8000	9.3	2.7	$286	$33.75
Sears	7800	9.2	2.7	$274	$35.15
Whirlpool	8000	9.3	2.7	$302	$37.75
York	7500	8.7	2.5	$274	$36.53

*EER = Energy Efficiency Ratio

$$= \frac{\text{Cooling Capacity (Btu/hr)}}{\text{Input Power (Watts)}} = 3.412 * \text{COP}$$

**COP = Coefficient of Performance

$$= \frac{\text{Cooling Capacity (Btu/hr)}}{\text{Input Power (Btu/hr)}}$$

TABLE 2

ELECTRIC BASEBOARD RESISTANCE HEATER COST DATA

FPECo Model	Rating (watts)	Length (ft)	Price[3]	Unit Price ($/KW)
BQ 295 12X	500	2	$18.30	$36.60
BQ 307 12X	750	3	$23.90	$31.87
BQ 410 12X	1000	4	$28.20	$28.20
BQ 512 12X	1250	5	$32.25	$25.80
BQ 615 12X	1500	6	$35.25	$23.57
BQ 820 12X	2000	8	$44.00	$22.00

ADDITIONAL COSTS PER BUILDING:

Thermostat: $20.00

Additional parts & wiring: $20.00

Installation labor: $300.00 [4]

TABLE 3

ELECTRIC HOT WATER HEATER COST DATA

Model	Capacity (gal)	Capacity (Units of 10^3Btu/hr)	Retail Price[2] (1977 $)	Unit Cost ($/1000 Btu /hr)
Wards 35170	52	38.41	120	3.12
A.O. Smith KEN52D	52	38.41	169	4.40
Rheem 10-666J	52	38.41	189	4.92
Jackson Executive	52	38.41	117	3.05
Rudd Holiday RH522	52	38.41	189	4.92
Sears 32461	52	38.41	138[5]	3.59
Sears 32471	66	48.75	165[5]	3.39
Sears 32481	82	60.57	180[5]	2.97

Installation and wiring costs
(excluding new plumbing): $65.00 [5]

TABLE 4

SUMMARY OF RESULTS

Component	Unit Price (dollars per capacity, installed)
Compressive Air Conditioner	$31.25 per 1000 Btu per hour
Electric Resistance Heater	$340.00 + $25.00 per Kilowatt
Heat Pump	$84.00 per 1000 Btu per hour
Electric Hot Water Heater	$65.00 + $2.60 per 1000 Btu per hour

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